

Biogas for Transportation: A Global Perspective

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Bryan Luftglass, Energy Segment Manager

bryan.luftglass@linde.com



Linde's profile



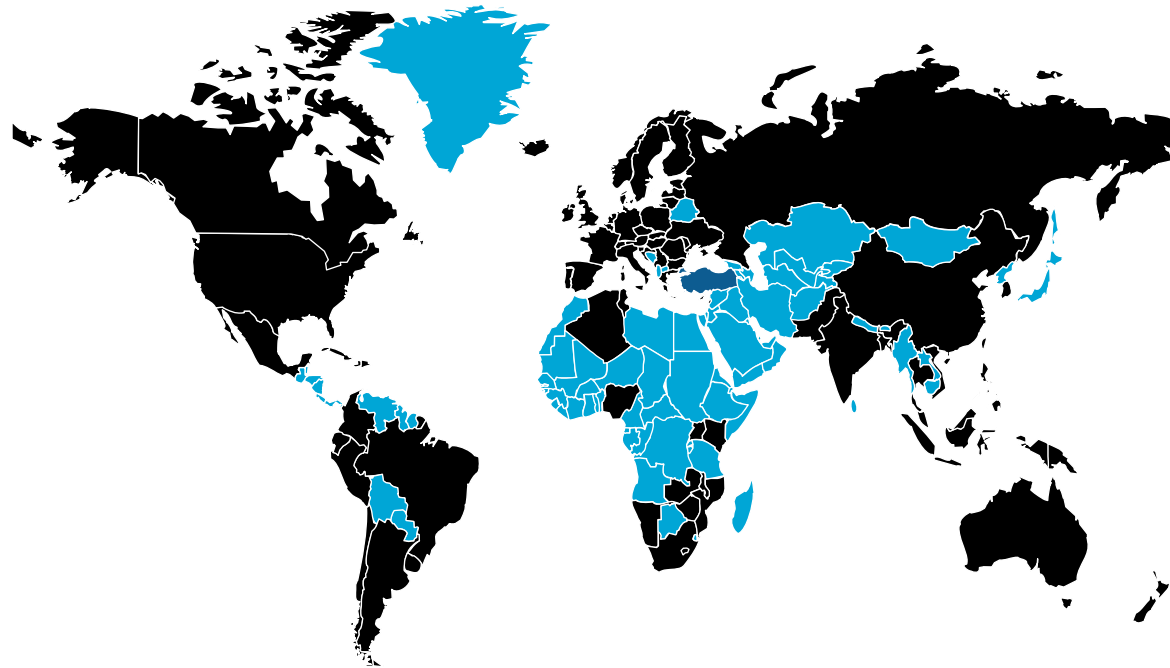
Global organization - over \$15 billion revenues, 50,000 employees

Supplier of compressed and cryogenic gases, e.g.,

- Atmospheric gases -O₂, N₂, Ar
- CO₂
- Helium
- Hydrogen
- Rare gases

Engineering and equipment, e.g.,

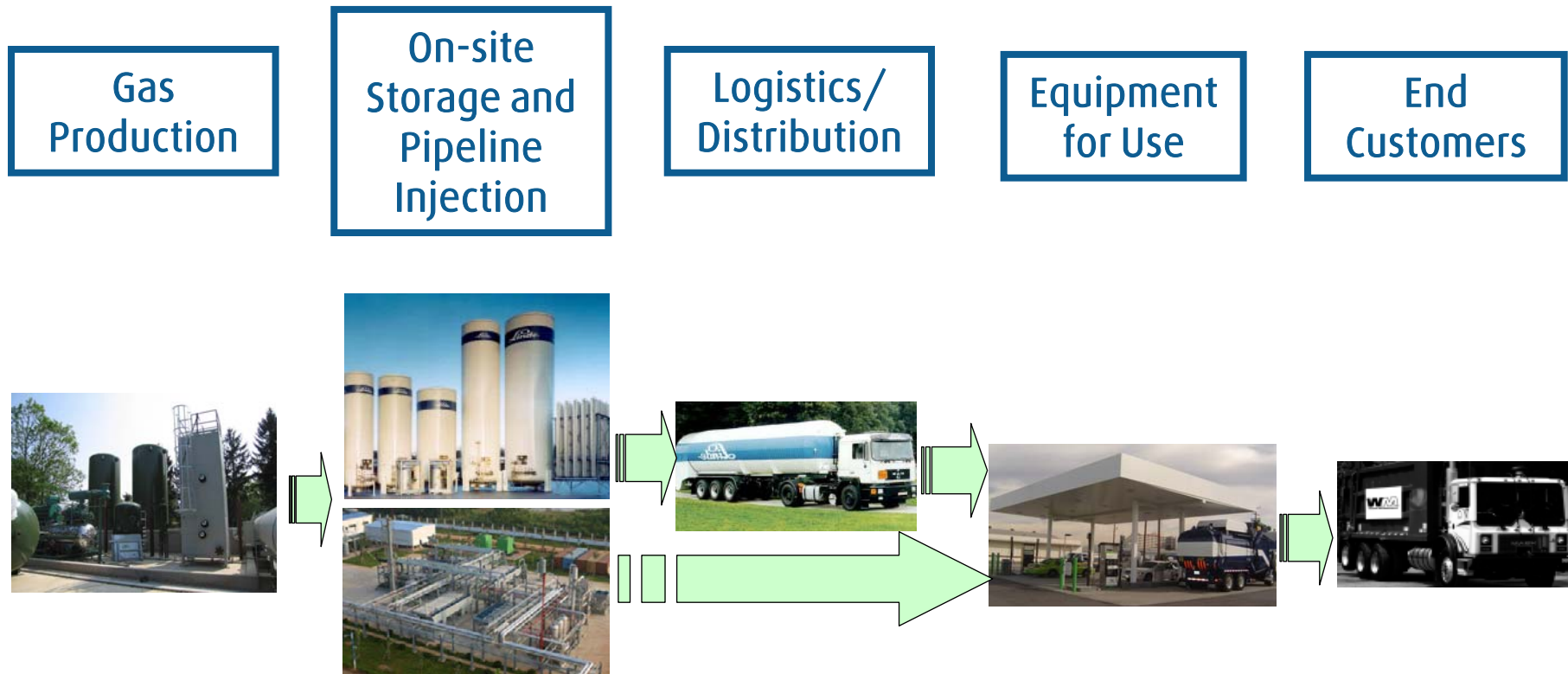
- Natural gas processing
- Petrochemicals
- LNG



The biogas-to-fuels business model is similar to industrial gases

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Technology

Process Excellence

Customer Focus

Some of Linde's related activities

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Biogas to CNG program
(Sweden)

LFG to LNG for transportation (UK)

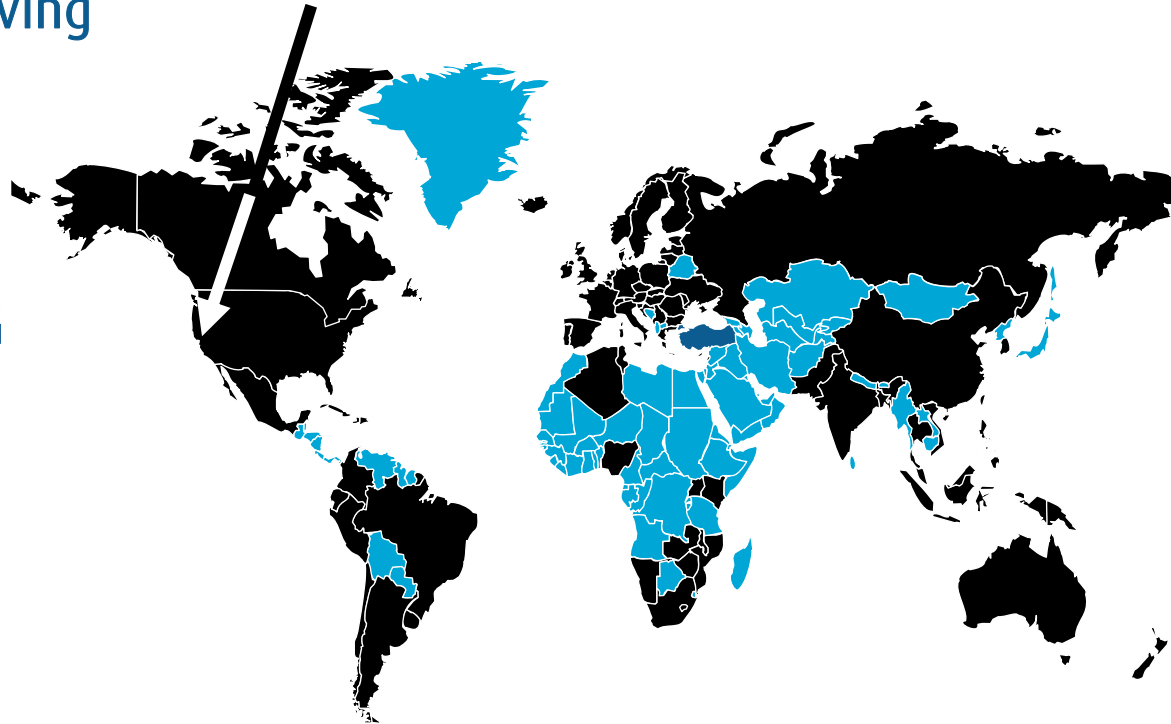
LNG for HD trucks and peak shaving
(Australia)

Biogas for advanced power

Design and manufacture of LNG
plants

LNG/LCNG fueling stations

LFG to LNG JV with Waste Management
(California, 2009)



Biogas to fuels program (Sweden)

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Local view of biogas

- Lowest emissions
- No added CO₂
- Locally produced
- Lowest energy cost
- Very safe



Approach

- WWTP sources
- Cost-effective biogas distribution
- High-quality fuel, consumer friendly

Status

- 15 public stations by end of 2009 (Linde owns 10)
 - 13 supplied by >100 Linde swap units, 2 by pipeline



Landfill gas to LNG system

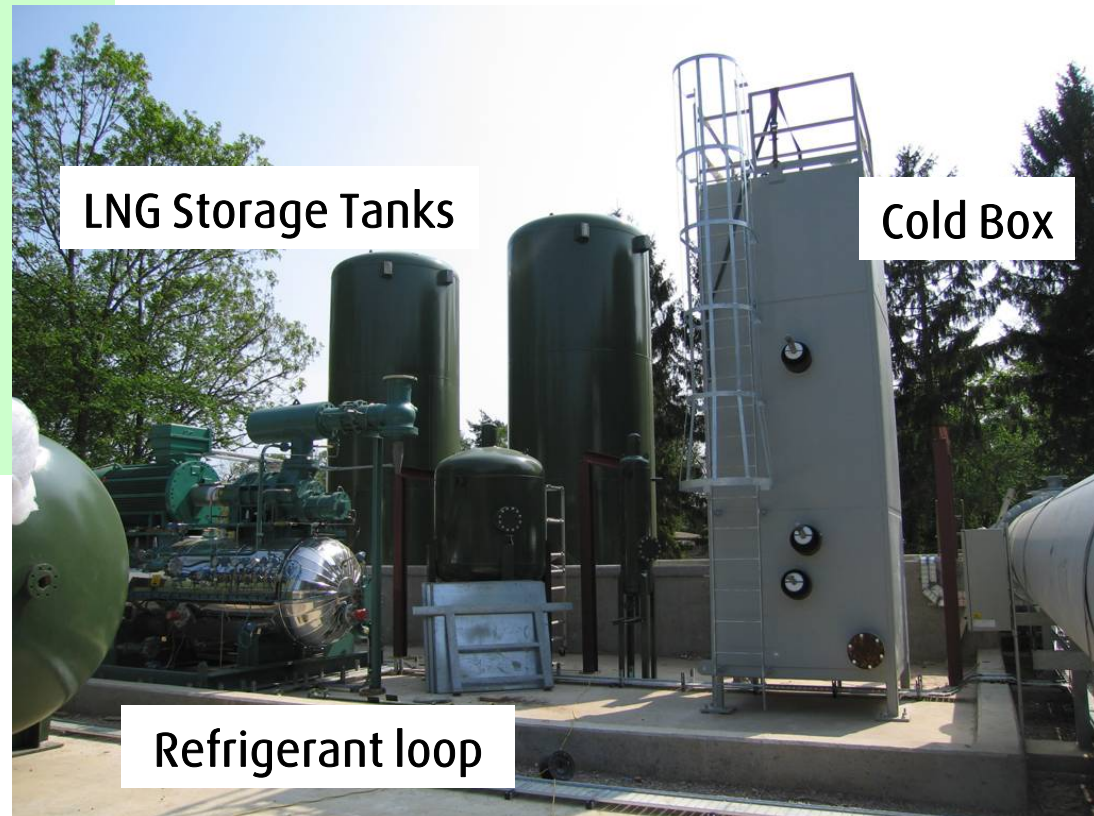
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10,000 GPD unit installed in 2008
Linde partnership with site owner, Gasrec

Based on GTI's liquefier design:

- Overcome economy of scale issues
- Optimize for energy efficiency
- Minimal life cycle costs
- Adaptable to various gas streams
- Robust



Conclusions



- Biogas direct to transportation fuels is difficult, risky and complex
But also technically and economically viable
- Competencies involved
 - System design
 - Cleanup +/-liquefaction with proven processing steps and standardization
 - Project development
 - Design and engineering, procurement/vendor coordination, site management
 - Plant operations
 - Optimization, control systems, feed gas management
 - Supply management
 - Plant networks, logistics
- Government support during the transition reduces risks and enables acceleration of technology and market development